

PAPER • OPEN ACCESS

## Cognitive differences between male and female students in higher order thinking skills

To cite this article: N P Anggraini *et al* 2019 *J. Phys.: Conf. Ser.* **1188** 012006

View the [article online](#) for updates and enhancements.



**IOP | ebooks™**

Bringing you innovative digital publishing with leading voices to create your essential collection of books in STEM research.

Start exploring the [collection](#) - download the first chapter of every title for free.

# Cognitive differences between male and female students in higher order thinking skills

**N P Anggraini, Budiyono, and H Pratiwi**

Universitas Sebelas Maret, Jl. Ir. Sutami No.36A, Surakarta, Jawa tengah 57126  
Indonesia

E-mail: nawangpusang@gmail.com

**Abstract.** Today gender issues about male and female have been highlighted. Especially in education, education must treat male and female equally. Education has many abilities who can make a difference between male and female. This research has an aim to analyze the differences between male and female student's abilities of higher order thinking skills. The method of this research is the quantitative method and followed by the analysis. The instrument is the essay question. The samples were taken randomly to represent the population. The results of this research indicate that male and female have the differences average at higher order thinking skills. Female students have a higher percentage than male in 4 indicators which is different, organizing, attributing, and checking but male students have a higher percentage just in 1 indicator than female which is producing indicators.

## 1. Introduction

These two creatures created in difference, ranging from the anatomy of the body, the character, the way to behave and the way of thinking. It is undeniable that there are a lot of studies comparing male students and female students. In education, many studies have compared ability between male students and female students. Educational studies are still upset between differences between male and female. The several research said that. Some researchers have demonstrated the existence of gender differences in general intelligence that favour men [1-2]. On the other hand, so many researchers not found the differences between male and female because of the abilities in the study not linear with gender [3-4].

In the first time, we will discuss brain anatomy. In the early 2000s researchers still questioned the anatomical differences of the brains of women and men. Joel [5] said that There are no true " male" and "female" brains out there to discover". [5] explained that the brain is not a "male" or "female", but the brain is intersex because the brain is a highly variable organ. Questions about the differences in male and female brains were answered in recent years which found differences in the brains of male and female. This difference is not large enough, but after being investigated, there is indeed a difference between male and female brains that influence the ways of thinking of these two this genders. This difference was revealed by Price, Price [6] said that "women tend to have thick cortices, whereas men had higher brain volume. Price also said that thicker cortices had been associated with higher scores on a variety of cognitive and general intelligence tests" Thicker cortices affect cognitive intelligence such as tests in education. This research said that female can win the competition from a male in cognitive and also wrote tests but a male is richer in ideas. Other than that, the study was refined by [7] who took



data from the study by Larry Cahill, PhD say that Adjusted for total brain size (men's are bigger), a woman's hippocampus, critical to learning and memorization, is larger than a man's and works differently. Conversely, a man's amygdala, associated with the experiencing of emotions and recollections of such experiences, is bigger than a woman's. We know that Hippocampus in the brain regulates the ability to memorize and learn while the Amygdala regulates Emotions as well as decision making.

In psychology, there is also any difference between women and men. According to [8], it stated that Gender differences certainly lead to physiological differences and affect the psychological differences in learning. This statement is supported by [9] who stated that gender differences not only result in abilities in mathematics but also how to acquire mathematical knowledge. This statement was reinforced by [10] that gender, social and cultural influence mathematics learning. Similarly, the results of the study by [11] suggested that gender differences affect students' problem-solving abilities, in which the problemsolving abilities of a male are better than female for middle and upper classes. Psychology influences education because behaviour in schools is very important for students to be better at following lessons.

In education, there has never been a study that revealed differences between female students and male students in the study. [8] stated that there is no research has examined directly the relation of mathematical proof to gender differences. Some researches only relate mathematical abilities in general to gender differences. In education, there are indeed some things that have been learned about intelligence and abilities, especially in mathematics. The several abilities of mathematics are that mathematical literacy skills say that male student are better at literacy skills than women because men are better at building ideas [12]. Another ability that is also important is the ability of mathematical creativity studied by [13] that women in grade 8 thus score significantly higher both innovatively and adhesively compared to men. If that true, women are better at creativity, women are considered more capable and faster in capturing learning because the use of the brain is more complex and balanced. In other mathematical skills such as mathematical reasoning abilities, [14] said that male students do significantly better than female students in mathematical reasoning. In mathematical communication skills, [15] said that men and women have the same abilities in that matter but female students can evaluate their mathematical ideas in writing or visual forms in mathematical written communication. We also know that female tended to be more diligent in learning than male. The statement also supports that in general, it was recorded that girls spend more time doing homework, display less disturbing behaviour in the classroom and play truant less often [16]. High motivation makes female students more diligent than male students, so that female students tend to be always more prepare in learning.

HOTS (higher order thinking skills) was initially differentiated based on Bloom's Taxonomy which was categorized at the level of thought, from the lowest to the highest, which are knowledge, understanding, application, analysis, synthesis and evaluation. Actually the learning objectives were divided into three domains. These three domains are cognitive domains, affective and Psychomotor. According to [17] said that based on research into the cognitive domain among middle school students, the first three categories of taxonomy, knowledge, understanding and application from Bloom measure students' low order thinking skills (LOTS), while the other three levels are analysis, synthesis, and evaluation measure higher thinking skills or HOTS. This cognitive domain was revised later by [18]. The order was changed to (1) remembering; (2) understand; (3) application; (4) analyze; (5) evaluate; and (6) creating. Levels 1 to 3, at that stage are categorized as low-level thinking abilities (LOTS). While points 4 to 6 are categorized as high-level thinking skills (HOTS).

The importance of implementing HOTS becomes very demanding at 4.0 because learning no longer sit and still listen to the teacher delivering the material. Learning becomes very important because it demands applications in the real world. According to [19] from the results of its application said that students have a positive view of the application of HOTS in the teaching and learning process because it benefits their real life. Since life has lots of challenges, students can be trained to think critically and

creatively. Students have a positive view of HOTS because they can play an active role in real life learning. Taken from the On review in A revision of Taxonomy Bloom states the Structure of cognitive process. The attention of the revised Taxonomy is C4 (analysis) any 3 indicators that are Differentiating, Organizing, and attributing. At C5 any 2 indicators that are checking, critiquing and at C6 is any 3 indicators that are Generating, Planning and Producing. From the above dimensions, I take 3 indicators for C4, 2 indicators for C5 and 1 indicator for C6 and define according to the ability of junior high school students [18]. These indicators will also be used as a reference in making test instruments to measure higher order thinking skills of students.

## 2. Method

In this research, the method used is a quantitative method to find out the difference in higher order thinking skills of female students and male students. The population in this research were all 8th-grade junior high school students in Surakarta. From the population, one school will be chosen to represent the population. The selection of the sample to represent school is done randomly. After randomly selecting the sample, SMPN 9 Surakarta represented the population. The students who were sampled at SMPN 9 Surakarta were 30 students. In collecting data, this research used a question or test. The students were given six essay questions, each of question presents each indicator, which is Differentiating, Organizing, Attributing, Checking, Critiquing, Producing and given 60 minutes to complete the test. The topic in the question is a linear equation in the form of a description that was previously validated by experts and tested. Analysis of the data used is a variance analysis test to determine the difference in high order thinking skills (HOTS) between two variables, which are male and female. Before the variance analysis test was carried out, a prerequisite test will be carried out, which are the normality test and homogeneity test.

## 3. Result and Discussion

The instrument is ready to measure students abilities, the instrument is given to students who have been selected as sample. After the results were obtained, the results are tested by variance analysis test, there are two prerequisite tests, which are the test for normality and homogeneity. The Normality Test using Shapiro-Wilk shows a significance of  $0.268 > 0.05$ , which means that the distribution of data in SMPN 9 Surakarta is normally distributed. The homogeneity test shows a significance of  $0.709 > 0.05$ , which means that the HOTS test results in the SMPN 9 Surakarta are homogeneous. The results of the variance analysis between two variables, which are male and female in SMPN 9 Surakarta are as follows:

This variance analysis test has an alpha of 0.05 and a hypothesis as below:

$H_0$ : Female and male students have the same HOTS test results

$H_1$ : Female and male students have an average HOTS test result that is not the same

With the results of the significance above which is  $0.033 < 0.05$ , then  $H_0$  is rejected and accepts  $H_1$  which is female students, and male students have an average HOTS test result that is not the same. Judging from the average results, female students have a higher average score than male students in SMPN 9 Surakarta that is equal to 48.21 and for male which is 42.82. Table 1 is the results of each indicator achieved by female students and male students.

**Table 1.** Indicators of Higher Order Thinking Skill in Mathematics

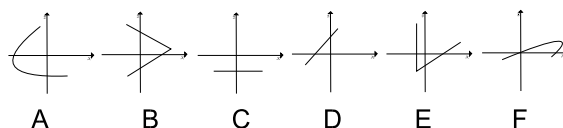
No	Indicators	GENDER			
		Male		Female	
		Score	%	Score	%
1	Differentiating	26	<u>46,4%</u>	35	54,7%
2	Organizing	39	<u>69,7%</u>	48	75,0%
3	Attributing	28	<u>50,0%</u>	35	54,6%
4	Checking	18	<u>25,7%</u>	35	43,8%
5	Critiquing	30	<u>42,9%</u>	34	42,5%
6	Producing	27	32,1%	29	30,2%

Tabel. 1 show that higher order thinking skills of 8th-grade students of SMP in Surakarta female students have better outcomes than students of male students. The highest ability of female students is in Organizing as well as male students, and the lowest ability of female students is in producing while male students are checking. This paper does not stop there in assessing the differences between female students and male students, there will also be differences between male and female students in each division.

3.1 Analysis (C4)

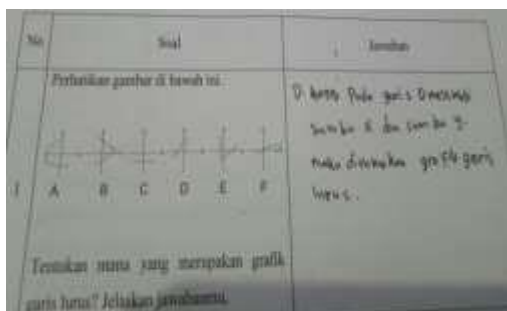
In the analysis, we have three indicators and three question which is present each indicator. We will discuss this question of analysis (C4) with the indicators Differentiating. In that question, students must choose the linear graphic and give the reason why they choose that. In that question any two answers. The answer is C and D.

Look at that picture.

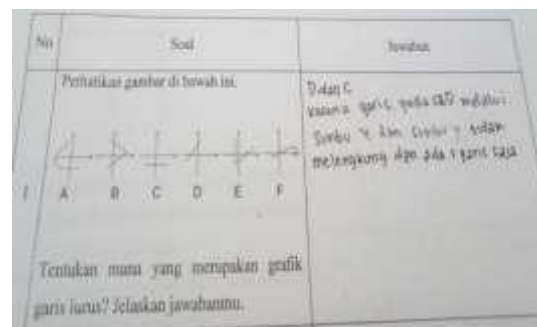


Which one the grafik linier? Explain your answer with good argument.

**Figure 1.** The equation in English for C4 Differentiating



**Figure 2.** Male student’s answer in C4



**Figure 3.** Female student’s answer in C4

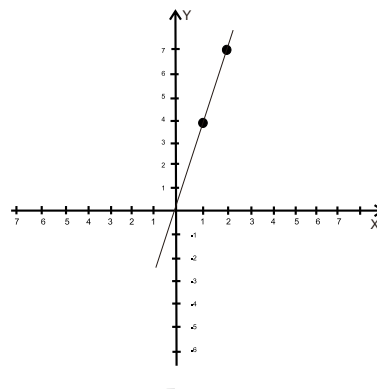
Figure 2 shows that male answer, male answer “D because the line D through X and Y, so that called the linear line”. This answer is not wrong but sketchy, and the complete answer is C and D. This indicated that male students make a decision fastly. That state supported by [20] that boys take it easier, work less hard and are distracted more quickly. When they find one answer, they do not try to find another possible answer. They feel that the answer is enough — the reason that male student also makes not complete. Figure 3 shows the female answer, and the female answer is “D and C because the line C and D through X and Y and not make hyperbole, so that is a linear line”. The female answer is complete and the reason also complete. The female student did not go so fast to think the answer, they more accurate than male. Female it can be seen that female students usually answer longer, while males show that male students respond briefly. Most female students answer correctly which indicates that female students are better able to analysis questions to be able to answer questions correctly. In male students, most students answer wrongly, or students only answer one correct answer, male students are accustomed to having got one correct answer they feel enough and not looking for the other possible correct answers. In the explanation they provide to support their answers, female students are more argumentative and rational in providing explanations. The explanation indicated that female students are better to analyze questions and answer with better-supporting arguments than male.

3.2 Evaluate (C5)

The question above is one of the questions in C5 with a checking indicator. In this indicator, male students have the lowest scores. This indicator requires students to check the state of the question submitted right or wrong and gave the correct reason for the answer that has been chosen.

Given a graphic linear

equation above this.

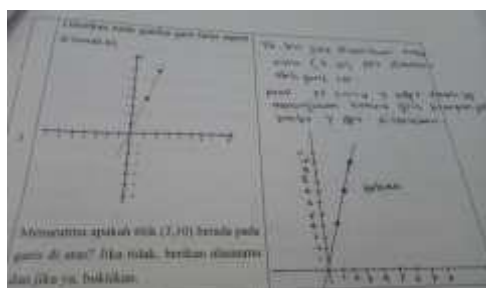


In your opinion, in that linear

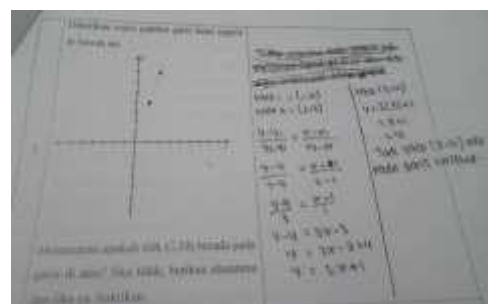
have the point of (3,10) in

there? If your answer is no, Give the reason and its yes, give the reason and prove it.

**Figure 4.** The equation in English for C5 Checking



**Figure 5.** Male student’s answer in C5



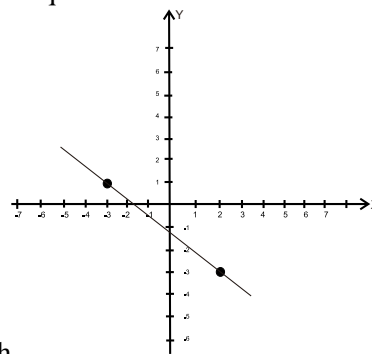
**Figure 6.** Female student’s answer in C5

Figure 5 showed the male answer in C5 indicators checking. The complete answer must have proof, why the students answer “yes”. The male students in figure 5 answer “yes because the axis Y and X can be continued to (3,10). The male students give the proof with a graphic. That answer is not wrong but not complete enough. Students must answer that “yes, (3,10) through the line with looking for the equation the line and substitution (3,10) to prove that the line passes the through (3,10). From figure 6 we can look that female answer is more argumentative compared to male students. The female students proof with explaining why they answer yes, they looked for equation line and substitution (3,10) but almost female not used the graphic to answer. Regarding evaluating, students are expected to be able to evaluate an incorrect or correct statement with the correct evidence and explanation. The figure shows that female students and male students mostly evaluate statements correctly, that point (3,10) is on the line but the explanation to support that answer is very different from male and female. Female students evaluate with the right evidence and support of arguments. Female students show evidence that point (3,10) is on the line by looking for the equation of the line and entering point (3,10) in the equation of the line (checking) and it turns out to be true. On the other hand male students only show a graph that the point (3,10) is on that line, in this case students are correct but evaluating is less accurate without supporting arguments. Male students here see that they are always looking for a quick way to answer questions. This is not good because male students will answer incorrectly and irregularly. Students' answers will be difficult to believe, according to the fact that proof in mathematics has a role of verification and justification, but in proof, is used for explanation.

### 3.3 Create (C6)

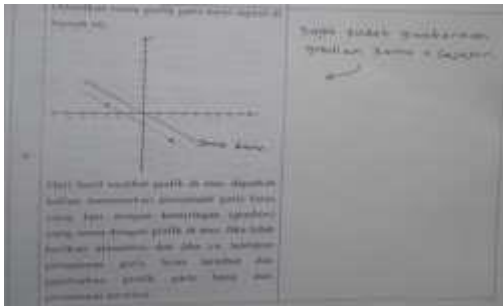
The equation above showed C6 and producing indicators. Students are expected to be able to make or produce something new, not that students must find something like research, but students can make something that was not explicitly ordered, such as the example above. Students are left to be able to create their straight line with any point that students want but must have the same gradient as the specified line.

Given a graphic linear equation above this.

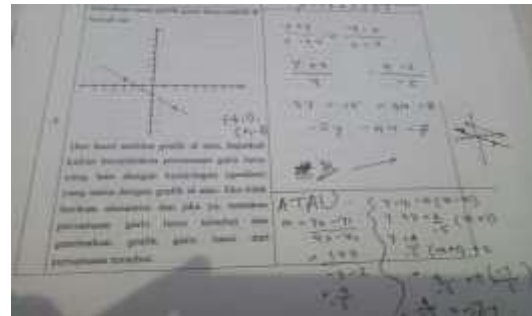


Can you create another linear equation with the same gradient from that graphic linear equation? If your answer is no, give a reason and if your answer is yes, please draw the line and prove it.

**Figure 7.** The equation in English for C6 Producing



**Figure 8.** Male student's answer in C6



**Figure 9.** Female student's answer in C6

Figure 8 showed that male students directly draw parallel lines without looking for a known line gradient, determine the point passed by the new line and do not determine the equation of the straight line. Figure 9 showed that female students are better at creating something new because female students create with systematic steps. From the explanation above, female students should have better grades, but from achievements that can be seen from the percentage of each indicator, men are better at creating. After reviewing all the answers from the male and female students, it can be said that almost all male students answer and drew parallel lines even though they are not done systematically while female students do not create anything when they could not do it. The smart female students answer completely and correctly, but female students that are not smart do not answer at all. That is the reason that the majority of male students who are either smart or are said to be less intelligent still have ways or ideas to answer the questions given. This is supported by the idea that men have a storehouse of ideas in their brains that are larger than women [7].

Female students on HOTS have better results in 4 indicators than male students and male students better result in 1 indicator. The male and female students are equal in 1 indicator. Female better in Differentiating, Organizing, Attributing, Checking and male better in Producing. They have the same quality at Critiquing. The ability of male students to be higher compared to female is supported by [12] that men are better at building an idea than women. The ability of female students in Differentiating, Organizing, Attributing and Checking is higher supported by a statement on the discussion that women's brains are designed to be better in learning such as memorizing and analyzing things as well as female students more thoroughly in conducting tests [7].

#### 4. Conclusion

Female students on HOTS have better results in 4 indicators than male students and male students better result in 1 indicator. The male and female students are equal in 1 indicator. Female better in Differentiating, Organizing, Attributing, Checking and male better in Producing. They have the same quality at Critiquing. The ability of male students to be higher compared to female was supported a statement that male is better at building an idea than women. The female students who is clever answer correctly and completely but the female students who are not clever enough not answer at all but the male students always have any idea to answer, the male student not afraid to answer the question with their idea. The ability of female students in Differentiating, Organizing, Attributing and Checking is higher supported by a statement on the discussion that women's brains are designed to be better in learning such as memorizing and analyzing things as well as female students more thoroughly in conducting tests.

## 5. Acknowledgement

The author thanks Universitas Sebelas Maret for giving me the opportunity to encourage and facilitate author to complete this research. Thanks also to the SMPN 9 Surakarta and the teachers who helped to facilitating me with their student as the subject in this research.

## References

- [1] Irwing P 2012 Sex differences in: An analysis of the US standardization sample of the WAIS-II *Personality and Individual Differences* **53** 126
- [2] Nyborg H 2003 *The scientific study of general intelligence: Tribute to Arthur Jensen*. Risskov (Denmark: University of Aarhus)
- [3] Burgaleta M., Head K, Álvarez-Linera J, Martínez K, Escorial S, Haier R 2012 Sex differences in brain volume are related to specific skills, not to general intelligence *Intelligence* **40** pp 60–68
- [4] Saggino A, Pezzuti L, Tommasi M, Cianci L, Colom R, & Orsini A 2014 Null sex differences in general intelligence among elderly *Personality and Individual Differences* **63** 53
- [5] Daphna J 2011 Male or Female? Brain are intersex *Journal of Frontiers in Integrative neuroscience* **5** 1
- [6] Michael P 2017 Study finds some significant differences in brains of men and women *E-journal of Science AAAS*
- [7] Bruce Goldman 2017 The cognitive differences between men and women *e-Journal of Stanford Medicine*.
- [8] Feriyanto 2018 The Ability of Students' Mathematical Proof in Determining the Validity of Argument Reviewed from Gender Differences *Journal of Physics: Conference Series* **947** pp 1-6
- [9] Susento 2006 *Mekanisme Interaksi Antara Pengalaman Kultural-Matematis, Proses Kognitif, dan Topangan dalam Reivensi Terbimbing* Disertasi (Surabaya: Unesa)
- [10] Keitel C 1998 *Social Justice and Mathematics Education Gender, Class, Ethnicity and the Politics of Schooling* (Berlin: Freie Universität Berlin)
- [11] Zhu Z 2007 Gender Differences in Mathematical Problem Solving Patterns: A Review of Literature *International Education Journal* **8** 187
- [12] Siti L 2017 Mathematical literacy skills of students' in term of gender differences *AIP Conferences proceeding* **1868** pp 1-10
- [13] William M B 2015 An Investigation of the gender Differences in creative thinking abilities among 8th and 11th grade students *Journal of Elsevier* **17** 17
- [14] Emerullah E 2017 Age And Gender-Related Change in Mathematical Reasoning Ability and Some Educational Suggestions *Jurnal of Education and Practice* **8** pp 2222-2888
- [15] Henry P I W, Imam S, Riyadi 2016 Students' Mathematical Communication Ability Is In Accordance With Gender In Problem Solving In Beams And Cubes *Journal of Mathematics learning* **8** 778
- [16] Mujahidah. 2009 Behavior Cheating between male and female at study of meta analysis *Journal of psikologi Samarinda* **2** 2
- [17] Saido G M, Siraj M, Nordin A B B and Al Amedy O S 2018 Higher Order Thinking Skills Among Secondary School Students in Science Learning *MOJES: The Malaysian Online Journal of Educational Science* **3** 13
- [18] David R K 2002 A Revision of Bloom's Taxonomy : An Over view *Collage of Education* **41** pp 212-218
- [19] Tajularipin S 2017 Implementaytion of Higher order thinking skills in Teaching of Science: A case study in Malaysia *International Research Journal of Education and sciences* **2** 1

- [20] Barber M 1996 *The learning game: arguments for an education revolution* (London: Victor Gollancz)